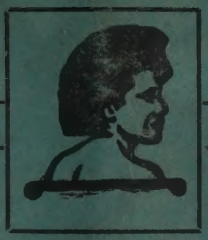
VOL. 26 NO. 3 SEPTEMBER, 1955



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2, 1921, 5 ,, 5, 1924-5, 2 numbers.
3, 1922, 4 ,,

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Rhinoceros Beetle Eradication Board. Report C.P. No. 39, 1954. Price 1s. 6d.
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Department of Agriculture Annual Report, 1953. C.P. No. 37, 1954. Price 5s. 6d.
Department of Agriculture Annual Report for 1954. C.P. No. 9, 1955. Price 2s.
Report by Sir Geoffrey Clay on his Visit to Fiji in 1954. C.P. No. 31, 1955. Price 1s. 6d.

OTHER PUBLICATIONS

A FEW copies of the following important book are available:—

The Coconut Moth in Fiji, by J. D. Tothill, H. C. Taylor and R. W. Paine. Imperial Bureau of Entomology, 1930. Price £1.

FORTHCOMING PUBLICATIONS

THE following publications are in the press and will be available shortly:—

Bulletin No. 28 ... ... Soil Erosion and Conservation in Fiji, by C. E. Whitehead (56 pp. and 60 illustrations). Price 2s.
Bulletin No. 29 ... ... Annual Reports of Divisional and Specialist Officers 1954. (60 pages). Price 4s.
Bulletin No. 30 ... ... The Grasses of Fiji by J. W. Parham (176 pp. and 73 illustrations). Price 5s.
Book ... ... The Fishes of Fiji by H. W. Fowler (approximately 600 pages and 200 illustrations).

Agricultural Journal

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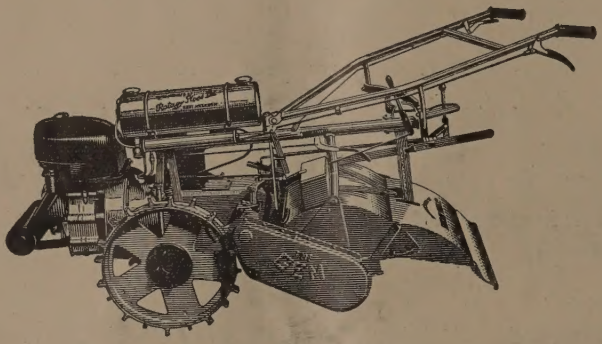

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EDITORIAL . . .

AGRICULTURAL CONFERENCE 1954

In December, 1954, the Deputy Director of Agriculture organised a conference of ex-students who had been trained at agricultural stations during the period 1932 to 1948 : and who had since been farming on their own account or were employed in various Government Departments. The theme of the conference was a strictly practical approach to present-day problems of agricultural development in Fiji.

1. Some of the members of the Agricultural Conference at Nasinu, December, 1954.

[Photo: R. Wright]

Ninety-six men from all parts of the Colony attended, 46 being Government officers from the Forestry, Education and Agricultural Departments. The remaining members represented all aspects of agricultural activity—banana, coconut and sugar growing, dairy cattle and pig farming. (Fig. 1).

Nineteen senior officers of the Department of Agriculture gave talks and demonstrations.

Ratu J. A. R. Dovi, M.B.E., Deputy Secretary for Fijian Affairs, attended the field day at Naduruloulou and planted a tree to commemorate the occasion.

The Conference, which by courtesy of the Director of Education and the Principal was held at the Nasinu Training College lasted four days and included field excursions as well as indoor discussions.

These culminated in a series of resolutions on the following major subjects relating to agricultural development from the viewpoint

of the Fijian and Indian farmer : rhinoceros beetle control, copra improvement, banana production, cocoa development, animal husbandry, agricultural equipment, soil conservation, agricultural training and education and co-operative societies as a valuable aid to agricultural development and community welfare.

2. Members of Conference watch demonstrations on cocoa propagation at Naduruloulou.

[Photo: R. Wright]

The field programme included visits to the Plant Introduction Station at Naduruloulou to see new crops as cocoa, pepper and pasture grasses (Fig. 2) : to the Principal Agricultural Station to study animal and crop research work and to demonstration areas for soil conservation. The Conference was marked by the keen interest of all present and ended with a resolution asking the Director of Agriculture to organise another conference within the period of the next three years. B.E.V.P.

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AGRICULTURAL STATIONS: NOTES ON CURRENT INVESTIGATIONS

1. ANIMAL HUSBANDRY

BY W. J. A. PAYNE

These notes will be published half yearly in order to inform the public on the progress of the animal husbandry projects at both Agricultural Station, Sigatoka and the Principal Agricultural Station at Koronivia. Full details of the results of all projects will eventually be published.

DAIRY CATTLE.

Breeding.—The transfer of the Friesians from Sigatoka to Koronivia has been completed, so that there are now Friesian and Jersey herds at Koronivia, and a Shorthorn herd at Sigatoka. A small experimental herd of sets of identical twins is also maintained at Sigatoka.

Progeny testing of the bulls in both the Friesian and Shorthorn herds has started. One Friesian bull has been progeny tested, and has been found to be of no use. He has been disposed of as has also a second closely related bull.

An Illawarra Shorthorn bull was imported from Australia this year for use in the Shorthorn herd at Sigatoka. He was picked not only because of his pedigree and type, but also because after a heat tolerance test at Grafton in New South Wales he was found to be the most heat tolerant of six bulls. It is thought that this is the first time that this method of testing a bull in the temperate zone for use in the tropics has ever been used. It was only possible to do this because of the close co-operation of the Department of Agriculture, New South Wales. The progeny test of this bull is awaited with interest.

Feeding and Management.—A new project was started at Sigatoka in June, 1954, in order to ascertain whether growth can be improved and calf mortality reduced by improved feeding and management techniques. The calves as they are born are placed on one of three primary treatments, (1) suckling on a foster mother, (2) bucket fed whole milk for one month then fed skim milk, and (3) bucket fed whole milk for two months and then fed skim milk. Calves on each primary treatment are subdivided into another three groups each group being given a separate type of supplementary feed, (*a*) a meal made from plant feeds only (*b*) the same meal with the addition of a small amount of " Distafeed ", a penicillin supplement and (*c*) a meal made up from a mixture of plant and animal feeds.

There are now 35 calves on the experiment, and it can be said that the suckled calves definitely have a better " bloom " than those that are bucket fed.

Although all the equipment and buildings were available it was not possible to commence the project comparing the effects of indoor versus outdoor feeding and management using eight sets of identical twins in 1954 as their importation from Ruakura Animal Research Station in New Zealand could not be sanctioned owing to an outbreak of leptospirosis in 1953. One trial has been made of the chromic oxide method of estimating the intake of dairy cattle. This has given the Biochemist and the staff at Sigatoka useful experience in the techniques involved.

BEEF CATTLE.

Breeding.—The Zebu herd at Sigatoka has now been established on the rough hill grazings. These animals are of the Ongole-Krishna Valley type but in the United States they would be classified as Nellore cattle. They are being bred pure, and the female breeding herd will be limited to twenty cows and heifers. Bulls and heifers will be available for sale in the future. The overseas demand for these animals in other South Pacific territories is very considerable.

A limited number of crossbred Friesian x Zebu and Shorthorn x Zebu heifers and bullocks are being raised. They are of a good beef type and appear to thrive on the rough hill grazings at Sigatoka. Their growth records are being compared with those of the two pure breeds.

Four Santa Gertrudis bulls for the " grading up " project were purchased in Australia and arrived in the Colony in April. The first crossbred calves should be born during 1956.

PIGS.

Breeding.—The Large White herd has been established at Koronivia and the Tamworth and Berkshire herds at Sigatoka. Purebred stock are being produced at both stations for sale to the public. Progeny testing of boars in all three herds has commenced.

At Sigatoka reciprocal crosses of Tamworth and Berkshire have been made in order to ascertain whether the crossbred is more suitable for commercial pork production than the purebred. A small number of Tamworth x Berkshire gilts are being bred to a Large White boar to investigate the desirability of the second cross, Tamworth x Berkshire x Large White as a commercial pork pig.

Two new boars one Tamworth and one Berkshire have been imported from Australia this year.

Feeding.—The first feeding trials using the new individual feeding pens have been completed. The first trial was planned to compare the value of rations containing plant or animal protein, and to obtain information on the most suitable mixture for optimal growth. A ration containing local feeds together with imported meat meal and buttermilk powder was shown to give excellent growth, and to be economic. Growth rates were as good as growth rates for porker pigs in the temperate zone.

A second experiment has confirmed these findings, and has also shown that addition of minute quantities of penicillin to the plant protein feed radically improves it as a fattening ration.

A piglet feeding trial has also been started to compare the value of animal and plant protein supplements for suckling pigs. No results are yet available from this trial.

GOATS.

Breeding.—The number of breeding does at Sigatoka is rapidly approaching the planned number of three hundred. When this occurs it will be possible to start the selection policy. This year the first crossbred Saanen x Fiji kids have been born, but it is not yet possible to see how they compare with the Angora x Fiji stock.

Feeding.—Half the herd have been drenched monthly for twelve months with a complete mineral mix containing iron, copper, cobalt, manganese and iodine, to ascertain whether there are any sub-clinical deficiencies in these trace elements in goats on the rough hill grazings. There is some indication that the drenched goats are slightly superior to those that are undrenched.

SHEEP.

Breeding.—The Veterinary authorities have not yet allowed the importation of the Wiltshire Horn sheep from Britain and the Black Bellied Barbados sheep from Barbados. As soon as quarantine difficulties have been setted a small number of animals of each of these two breeds will be imported and crossbred in an effort to obtain a sheep suitable for the local climate.

POULTRY.

Breeding.—Flocks of White Leghorn, Rhode Island Red, and Australorp have been established at Koronivia. Arrangements are being made to progeny test the cockerels in one or more of these flocks.

FISH.

The importation of the carp *Tilapia mossambica* from Malaya to Sigatoka has been successful. Fish imported as fingerlings in January, 1954, had bred by March, and there are now a large number of these fish in the breeding pond at Sigatoka.

No fattening ponds have yet been constructed but the first fifty imported fingerlings appeared to fatten rapidly in the breeding pond. Fingerlings are available for sale at Sigatoka.

FODDER AND PASTURE INVESTIGATIONS.

These are all conducted in association with the Biochemist and the Agronomist.

Fodder grass trial.—A fodder grass trial at Sigatoka during 1950-53 showed that elephant grass (*Pennisetum purpureum*) was the most suitable fodder grass for the area. It is now being grown extensively on the station.

A second trial has been started to ascertain the best height for cutting or grazing, and to see whether the presence of legumes and/or the addition of manure improves the production and/or the quality of an elephant grass pasture.

Pasture grass cutting trial.—A replicated trial designed to ascertain the nutritional value of seven grasses that thrive at Sigatoka was started in December, 1954. The seven grasses are Nadi blue grass (*Dichanthium caricosum*), Vuda blue grass (*Dichanthium* spp.), woolly finger grass (*Digitaria melangiana*), para grass (*Brachiaria mutica*), guinea grass (*Panicum maximum*), dallis grass (*Paspalum dilatatum*) and jaragua grass (*Hyparrenhia rufa*). The grasses are cut at three different heights designed to simulate three different levels of grazing and samples are analysed from each cut.

2. MECHANISATION

By R. R. MASON

This work has been severely handicapped by staff shortages and was also delayed by late arrival of certain machinery, so trials are not complete. Work has been concentrated on cultivation of wet padi land. This can be divided into two stages. The preparatory work of burying weeds and volunteer rice has been tackled in two ways : by ploughing, or rolling. To negotiate the softness and muddiness, double rear wheels were fitted to a Ferguson. Double pneumatics were tried first, but de-bogging was very difficult. The use of 11-inch pneumatics on the inside with standard steel wheels outside was much more satisfactory. Wider tyres on the front wheels (5.50 inches instead of 4.00 inches) were also an improvement. In order to accommodate the double wheel in the furrow bottom, a Reid and Grey mounted swamp plough was obtained. This turns a good shallow furrow 18 inches wide, but is excessively heavy, the weight being a limiting factor on very soft ground.

The alternate preparation is by rolling ; a heavy vaned steel roller, of the Malayan Kedah type, was made locally by the Public Works Department. Its use however was limited by the fact that it is necessary for the land to be covered by water, for otherwise the vanes clog with mud ; and without controlled irrigation, this condition is difficult to fulfil. It also appears necessary to have sharp edges to the vanes, to cut through the weed growth and incorporate it in the mud.

It was also hoped to try out a Fishleigh trailed rotary cultivator, but the machine was late in arriving and was not tried extensively. It is intended to replace the wheels with skids for next season. The machine is heavy and has a high power requirement. It lacks a self-lift or hydraulic lift for use when turning on the head land.

For the final working-down and puddling of the land before transplanting, a lighter roller or harrows or the tractor wheels have been used. The drum roller, again a copy of a Malayan type, consists of 44 gallon drums with vanes fixed radically along the sides. It can give a very nice effect, but its draught was frequently enough to bog the tractor which however could travel light surprisingly well even in very soft conditions. (The Ferguson with double wheels was being used). It was found that the effect of the double wheels was to bury weed growth and to produce a well-puddled mud into which seedlings could be transplanted ; a considerable area was prepared in this way.

Swamp blocks had previously been tried on the little Ransomes MG5 with very good results, and in this last season a Bristol

(*Continued on page 97*).

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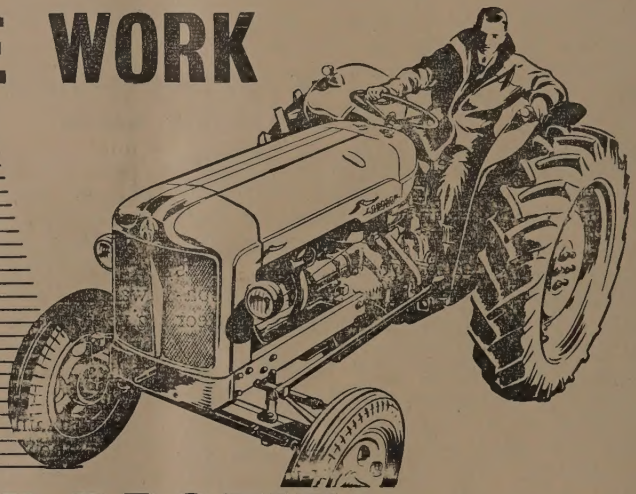

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AGRONOMY . . .

THE USE OF FERTILIZERS

FERTILIZERS ARE AN ADJUNCT TO GOOD HUSBANDRY—NOT A SUBSTITUTE FOR IT

BY A. R. BROWNING

The following notes give some idea of the kinds and amounts of fertilizers likely to be beneficial locally. The recommendations are based on the known effects of fertilizers generally, considered in light of local crops and conditions, and are intended to serve as a guide until more precise information is available. It is probable that some of them will be changed as a result of experimental work in the future. In the meantime, however, application of fertilizers as set out should be beneficial in most parts of the country.

APPLICATION.

Fertilizers should always be placed under the ground where possible. (It is not possible, for instance, when topdressing pastures). Plants take up nutrients through their roots, and it is in the root zone that fertilizers should be placed. If mixed fertilizers are literally "topdressed", that is, put on top of the ground around plants, there is a tendency for several undesirable effects to come into operation. These are largely tied up with the behaviour of phosphates in soil. Phosphate is "fixed", or rendered unavailable to plants, by free iron and aluminium in the soil solution. Tropical soils, in the main, contain relatively large amounts of free iron and aluminium. When phosphates are applied to the top of the ground they dissolve and commence to move downward through the soil into the root zone. Before the dissolved phosphate has penetrated more than an inch or two into the soil, however, the greatest part of it, up to 90 or more per cent, will have been fixed, and rendered comparatively useless to plants. This fixing of phosphates goes on whether fertilizer is placed on top of the ground or underneath the surface, but if phosphates can be put into the root zone, or if their journey downward into the root zone can be shortened by putting them under the surface in the first place, there is a better chance that a larger portion of any applied phosphate will be used by plants. Roots will at least have a chance to compete.

Although fixation must be almost complete in the top inch or two of most tropical soils when phosphates are applied to the surface, very small quantities will penetrate into the upper part of the root zone and promote increased root growth there, in an attempt by the plant to make the most of the phosphate that has been applied. When this happens the plant becomes shallow rooted, the more so the more topdressing that is done. The two worst effects of this are, that the plant will become more susceptible to uprooting by wind (likely to be very important for crops such as bananas) and will be more likely to suffer from drought conditions because of increased surface rooting.

These are, very briefly, some of the reasons for putting phosphates *into* the ground wherever possible, rather than *on* it. The same sort of argument applies, although in a lesser degree, to other fertilizer elements which, insofar as it is economic and practicable to do so, should be placed in, or as near as possible to, the root zone; if for no other reason than that heavy rain soon after application may wash away much of any fertilizer which is on top of the ground.

Whenever possible, then, put fertilizers *under* the ground.

Transplanting.—Seedlings, cuttings, lettuce, cabbage, tapioca, dalo, bananas, etc. Make the planting hole a few inches deeper than usual, place fertilizer in bottom, cover with a few inches of soil and then plant in

the usual way. Do not stir the fertilizer into the soil, simply place it in the bottom of the planting hole and leave it undisturbed. The amount of soil used to cover the fertilizer before adding the plant will vary—say six inches for larger plants like bananas, to one or two inches for smaller plants like lettuce or cabbage. Do not let seedlings or cuttings come into direct contact with the fertilizer, it will burn them and retard establishment.

Seeding.—Beans, peas, carrots, lettuce, cabbage, flower seeds, etc. Prepare the seed bed in the usual way. Make a trench about four inches deep and four to six inches wide. Run fertilizer along the bottom of the trench on each side. Fill the trench with soil, taking care to disturb the fertilizer as little as possible, and plant seeds in the usual way, so that they are located above and *between* the two bands of fertilizer. It is particularly important to ensure that no fertilizer is directly under seeds of carrots, table beet and such root vegetables because roots of these plants will fork if they come into direct contact with fertilizer. When seeds are broadcast, the seed bed should be prepared in the usual way and fertilizer spread and lightly worked in, last thing before sowing.

Topdressing.—Tree crops—Bananas, etc. In a general way the root system of a plant tends to mirror its above-ground part, so that if the canopy of a tree, or the leaves of a banana extend out from the trunk by, say, five feet, the root system will tend to extend a similar distance out from the trunk, underground. Kramer, in *Plant and Soil Water Relationships*, gives examples of two very different types. One, a ten-year old horse-radish plant which had a root system only three feet in diameter, but extending into the soil fourteen feet ; the other a squash plant eleven weeks old, which had only a few sparsely branched roots extending to a depth of six or seven feet, and most of its roots in the top twelve inches completely occupying a circle of fifteen feet radius. Fertilizers should be placed somewhere between the trunk and the outward extent of the root system, that is, somewhere between the trunk and the edge of the canopy. To quote Kramer again ; " it is common for roots of trees to extend out two or three times the radius of the branches, although the region of maximum concentration of absorbing roots is, as a rule, probably under the periphery of the crown ".

The best way of getting fertilizer into the ground around tree crops will vary. It may be possible, for instance, with small tree or shrub crops planted in rows, to use a fertilizer drill, or plough a furrow alongside the rows and place fertilizer in the furrow, either right along if the crop is closely spaced, or opposite each plant if the distances apart are more than, say, three feet. The whole furrow, or that part of it where fertilizer has been placed, should be roughly closed. The use of such methods will depend on whether deep enough placement can be achieved close enough to the plants to be worthwhile, without damaging the roots too much.

When plants are not in rows the use of implements will usually be ruled out and hand methods will have to be used. Holes can be dug around trees at depths varying from one to two or three feet depending on the size of the trees, and fertilizer placed in the bottom. The holes should be filled again without disturbing the fertilizer. From three to eight holes should be used depending on the size of the trees. No attempt should be made to find the original holes in subsequent years. It is better that fertilizer should be spread evenly around trees over the years. This method has the advantage of getting fertilizer well into the soil, but the disadvantage of cutting many roots. The next method described, which has been used with success in fertilizing bananas during the last two years in Fiji, has the advantage of disturbing the root system less, but does not get the fertilizer so deeply into the soil. The method is to make a vertical cut to the full depth of a spade, wrench the spade back and forth a few times and then pour fertilizer down the spade cut. Close the top of the cut with the heel. Cuts should be radial, that is, " pointing " towards the trunk as the spokes of a wheel " point " towards the hub. In this way only a few roots will be cut. From four to eight cuts should be made around each tree and a portion of the fertilizer poured into each. Some fertilizer will stick to the sides of the

cut, but if the soil is reasonably dry and a clean spade is used, most of it will drop to the bottom.

There will be circumstances when it is not practicable, or economic, to use either of the methods described above, and when fertilizers if they are to be used, will simply have to be broadcast around trees. In most cases this will result in less efficient use of applied fertilizers, but because of the smaller labour requirement, the method may still be economic, wastage of fertilizers being made up by saving of labour costs. In general however, if it is worth buying fertilizer, it will be worth spending money to ensure that it is properly used. Too many times have reports concluded " no response to phosphates " when they should have concluded " no response to phosphates because of the way they were used on this occasion ".

Topdressing.—Row crops—Tomatoes, bele, carrots, beans, peas, etc. The same general remarks apply as before. Fertilizer should be put into the ground, not onto it. For short rows, a furrow three or four inches deep should be made with the corner of a dutch hoe or other suitable tool and the fertilizer run along the furrow, which should then be closed without disturbing the fertilizer more than necessary. Lettuce, cabbage, tomatoes and such plants may be topdressed by sprinkling fertilizer round each plant and working in lightly to a depth of a few inches with a small hand tool or stick. Furrows or sprinkled fertilizer should be from two or three to six inches away from the stems of plants according to their size. In market gardens, or where long rows need to be topdressed, a small fertilizer drill should be used. Be careful not to let fertilizer get on the leaves of plants when topdressing—it will burn ; and do not disturb the roots more than necessary. Both will check growth.

Fertilizer mixtures.—The formulæ 5:10:5, 2:17:4, etc., which appear in the following are given for those who may wish to know what the recommendations mean in terms of other literature they may read. The figures stand for lb per hundred pounds of mixture, of nitrogen, phosphorus pentoxide and potassium oxide, or N, P_2O_5 and K_2O, as they are frequently written. That is, a 5:10:5 mixture contains 5 lb of N, 10 lb of P_2O_2 and 5 lb of K_2O in every 100 lb. Nitrogen is usually supplied in mixtures by ammonium sulphate which contains about 20 per cent of nitrogen, but other compounds of nitrogen may be used. Phosphorus is usually supplied as superphosphate which contains about 20 per cent of soluble P_2O_5. Other, more concentrated, phosphates are being used increasingly overseas but are not available in Fiji at present. Potassium is usually supplied as potassium sulphate or potassium chloride (muriate), the sulphate containing some 50 per cent of K_2O equivalent, the chloride some 60 per cent when pure.

To make up, say a 5:10:5 mixture the following would be needed :

In each 100 lb of mixture		
Ammonium sulphate	25 lb =	5 lb of N.
Superphosphate ...	50 lb =	10 lb of P_2O_5
Potassium sulphate	10 lb =	5 lb of K_2O
Sand or other inert material	15 lb	
Total	100 lb	

This is one way of making up a 5:10:5 mixture, that is, one which contains 5 lb of nitrogen, 10 lb of P_2O_5 and 5 lb of K_2O per 100 lb. Sometimes as in the case of a 5:11:10 mixture, no filler is needed:

In each 100 lb of mixture		
Ammonium sulphate	25 lb =	5 lb of N.
Superphosphate ...	55 lb =	11 lb of P_2O_5
Potassium sulphate	20 lb =	10 lb of P_2O
Total	100 lb.	

Ammonium sulphate, for instance, by itself constitutes a 20:0:0 mixture.

In each 100 lb of mixture.		
Ammonium sulphate	100 lb =	20 lb of N.
Superphosphate ...	0 lb =	0 lb of P_2O_5
Potassium sulphate	0 lb =	0 lb of K_2O
Total	100 lb	

Superphosphate alone, can be thought of as a 0:20:0 mixture, and potassium sulphate alone, as a 0:0:50 mixture.

Whenever a mixture is given the three figures always stand for N, P_2O_5 and K_2O in that order.

NOTE.—A 5:10:5 mixture is not the same thing as a 1:2:1, and figures given in a mixture cannot be simplified without altering their meaning.

A 5:10:5 mixture contains

5 lb N	= 25 lb	Ammonium sulphate.
10 lb P_2O_5	= 50 lb	Superphosphate.
5 lb K_2O	= 10 lb	Potassium sulphate.
	15 lb	Filler.
	100 lb	

A 1:2:1 mixture contains

1 lb N	= 5 lb	Ammonium sulphate.
2 lb P_2O_5	= 10 lb	Superphosphate.
1 lb K_2O	= 2 lb	Potassium sulphate.
	83 lb	Filler.
	100 lb	

Recommendations have been culled from a variety of Agricultural Journals and other publications from a number of tropical countries and have been adapted and grouped where possible, so that a separate mixture need not be made for every crop. For instance, recommendations such as 4:12:4 for kumalas, and 5:10:5 for cabbages have been put, with several others, into a single group for which a 5:13:5 mixture is recommended. While, as mentioned above, these recommendations may not constitute the "last word" for Fiji's soils, climates and crops, they will be found in most cases to be a good deal better than no recommendations at all, and may be followed with confidence.

Mixture No. 1. 5:13:5.

Ammonium sulphate 5 parts by weight.
Superphosphate ... 13 parts by weight.
Potassium sulphate . 2 parts by weight.

Make up any required total amount using these proportions, mix thoroughly, and apply as follows for the crops below.

Avocado.—When planting, 10 to 12 oz of mixture in the hole. Thereafter, or for established trees, 10 to 12 oz round each tree in March July and November.

Cabbage.—(English and China). Apply at the rate of 2 to 3 oz of mixture per yard of row, or 4 to 6 oz per square yard in beds. If transplanting put about half an ounce in each hole. Topdress with 2 to 3 oz of *ammonium sulphate* per square yard in beds, or 1 oz per yard of row, when about half grown.

Bele.—When planting, 1 to 2 oz of mixture in each hole. Topdress with 1 oz of *ammonium sulphate* about every six weeks. For established plants, topdress with 1 to 2 oz. of mixture and then topdress with ammonium sulphate. Twice a year topdress with 1 to 2 oz of mixture. Bele is usually severely attacked by leaf miners, but if the plants are kept healthy and vigorous damage by insects can be greatly reduced.

Dalo.—Apply 2 to 3 oz in the hole when planting. Little can be found about fertilizing this crop and this recommendation is tentative. It will likely be altered in light of trials being carried out, but, in the meantime, this mixture will certainly be beneficial on poor land.

Ginger.—Apply in the drill at the rate of 3 to 4 oz per yard of drill when sowing. Ginger pieces should be sown about 1 foot apart in 2 foot rows, from August to mid-October. Side-dress rows in December with 2 oz per yard (1 oz per yard each side) of the following mixture.

Ammonium sulphate 5 parts by weight.
Superphosphate ... 4 parts by weight.
Potassium sulphate . 1 part by weight.

Kumala : 2 to 3 oz in the hole under each cutting ; well rotted organic matter should be incorporated in mounds, if available, in addition to the mixture.

Lettuce.—As for cabbage.

Pawpaw.—Apply at rate of 2 to 3 oz per square yard in seed beds. For seedlings and grown trees, as follows.

Trees up to 3 months : 3 oz per tree in April, September, November and February.

Trees 3 to 6 months : 9 oz per tree in April, September, November and February.

Trees 6 to 12 months : 12 oz per tree in April, September, November and February.

Trees over 12 months : 1½ lb per tree in April, September, November and February.

Plantings should be carried out in one of the four months above, and as soon as seedlings are established, a 3 oz. dressing should be given. Three months later, a 9 oz dressing, and three months later a 12 oz dressing. Thereafter, 1½ lb each three months. If commencing to fertilize established trees, begin at any time with dressings according to age. Choose a light, sandy well-drained soil for pawpaws. Fertilizers will not help to overcome the effects (common on heavy soil) of root-rot organisms which result in spindly top and failure to bear ; but they will promote heavier crops while trees on heavy soil continue to bear.

Tapioca.—Three to four cwt per acre, in the row, when implements are used. Otherwise, as for kumala, in hills.

Yam.—As for kumala.

Mixture No. 2. 5:10:12.

Ammonium sulphate 1 part by weight.
Superphosphate ... 2 parts by weight.
Potassium suphate . 1 part by weight.

Make up any required total amount, mix thoroughly and apply as follows, for the crops below.

Bananas.—Apply 12 oz per stool, in the hole, when planting. Thereafter 12 oz per stool every six months. In between these dressings of mixture, apply 3 oz of ammonium sulphate per plant about every six weeks, so that plants receive mixed fertilized followed by three lots of ammonium sulphate, followed by mixed fertilizer and so on. Ammonium sulphate need only be sprinkled round the stool and lightly worked into the soil. It is most important to keep bananas well weeded and to restrict the stool to three suckers in such a way that when the first throws its bunch, the second is about half grown and the third about three feet high. When the bunch is harvested from the first sucker this should be cut out and a third, new sucker allowed to come away. In this way three suckers are maintained and it will be found possible to harvest three well grown bunches about every twelve months from a single stool. Unwanted suckers should be cut out carefully, just below the ground, and not allowed to grow to any height. These may be used for planting if care is taken to get the whole bulb, or corm, out. "Root" suckers which come up some distance from the parent are more firmly rooted than "stem" suckers which arise on or near the parent, and the former should always be left as followers if possible. Dusting with DDT powder is essential for control of "scab". (See *Fiji Agricultural Journal*, Vol. 20, No. 3, September, 1949, pages 84 - 86.) Plant 11 to 12 feet apart in rows.

Carrots.—Best grown without fresh addition of fertilizer in soil which was well fertilized for the preceding crop. If this is not possible, use the mixture at the rate of 3 to 4 oz per yard of row. (1½ to 2 oz per yard, each side.) Be especially careful that there is no fertilizer directly below the seeds for at least 2 inches on either side, otherwise the roots will fork and the crop be of little value ; this applies to freshly added organic manures also.

Egg plant.—Use 2 to 3 oz of mixture per square yard in seed bed, 3 oz in the hole when planting out, and 3 oz worked in around plants when about half grown. Egg plant is subject to severe attack by insects about fruiting time when it is frequently almost completely defoliated. If plants are pruned right back after the fruit is harvested, and topdressed with 3 oz of the mixture followed by a further 3 oz when again about half grown, it is possible to get three or four good crops from each plant.

Peppers.—(Chillies, capsicum, etc.) Apply as for egg plant.

Tomatoes.—Apply as for egg plant.

Mixture No. 3. 8:9:8.

Ammonium sulphate 10 parts by weight.
Superphosphate ... 11 parts by weight.
Potassium sulphate . 4 parts by weight.

Make up any required total amount, mix thoroughly, and apply as follows for the crops below.

Cucumbers.—Apply at the rate of 700 lb per acre in the row when planting. (700 lb per acre equals approximately 3 oz per yard.) Side dress during the growing period with three applications of 125 lb. per acre in the row, of the following mixture. (Equals about ½ oz per yard.)

Ammonium sulphate 4 parts by weight.
Potassium sulphate . 1 part by weight.

Well rotted animal manure, good compost, or both should also be worked into the soil when preparing for the crop, at rates up to 10 tons per acre if available, preferably several weeks ahead of planting. (10 tons per acre equals about 5 lb per square yard.)

Passion fruit.—Apply at the rate of 1 lb per vine, worked into soil in a band 12 to 18 inches wide about 18 inches to 2 feet out from the stem. Topdress twice during the growing season with 3 oz of ammonium sulphate.

Squashes.—Pumpkins, marrows, gourds, as for cucumbers.

Watermelons.—As for cucumbers.

Legume Mixture : 1:11:20.

Ammonium sulphate	1 part by weight.
Superphosphate ...	11 parts by weight.
Potassium sulphate .	8 parts by weight.

Make up any required total amount, mix thoroughly and apply as follows for the crops below.

Peas, beans (all varieties), pulses, peanuts.—Apply in bands at rate about 2 oz per yard of row. (1 oz per yard of row on each side.)

Agricultural lime at the rate of 1 lb per square yard, dug in when preparing the ground, preferably a week or two ahead of planting, will be beneficial on most soils which are not formed on lime-rich material such as parts of the soapstone on the Suva Peninsula.

Tobacco Mixture : 2:16:5.

Ammonium sulphate	1 part by weight.
Superphosphate ...	8 parts by weight.
Potassium sulphate .	1 part by weight.

Make up any required total amount, mix thoroughly and apply to tobacco at the rate of 4 cwt per acre in the row when planting. Tobacco is more affected by a number of nutrient deficiencies than many other crops. (Quality of tobacco is also adversely affected by excess of nitrogen and this element should be used sparingly in fertilizer mixtures.) This mixture can be expected to give good results on many soils. Should it fail to do so, planters should apply to their nearest Agricultural Officer for advice.

Cacao Mixture.

Ammonium sulphate	5 parts by weight.
Superphosphate ...	5 parts by weight.
Potassium sulphate .	3 parts by weight.

Make up any required total amount and apply as follows.

2 oz per tree in the hole when planting.

2 oz per tree lightly worked in six months later.

4 oz per tree lightly worked in each year thereafter.

(This is a general recommendation which will be suitable in many cases. Growers going in for cacao on a large scale should consult the S.A.O. (Cacao) before embarking on a fertilizer programme.)

Coffee Mixture. 9:7:10.

Ammonium sulphate	9 parts by weight.
Superphosphate ...	7 parts by weight.
Potassium sulphate .	4 parts by weight.

Make up any required total amount, mix thoroughly and apply as follows. One hundred and twenty lb per acre, around trees, a week or so before blossom for the main crop appears. Three months later, 100 lb ammonium sulphate per acre, round the trees, and three months later 120 lb of mixture again. Three months later, 120 lb of mixture, commencing again at pre-blossom for the second crop, and so on.

GENERAL NOTES.

Compost.—Well made compost should be used whenever possible at rates up to 30 tons per acre. (Equals 15 lb per square yard.) It should be well worked into the soil a few weeks before planting, and should never be left lying on top of the ground if this can be avoided. Compost should be made in bins, using alternate layers of soil and vegetable matter—enough vegetable matter to compress to a layer six or eight inches thick, alternated with four or five inches of soil. Bins should be covered to prevent leaching by rain and to prevent conditions becoming so wet as to slow down, or even stop, the functioning of the various organisms which convert raw vegetable matter into good compost. Compost will be much improved if agricultural lime is sprinkled on

top of each layer of soil, at the rate of ½ lb per square yard. Turn the heap twice or three times at two or three weekly intervals until a good clean, sweet-smelling, crumbly product results. If the heap stinks it will generally be found that it is too wet, that insufficient soil has been added, or that more lime is needed. Both the hand and the nose should be regaled by good compost—if either or both is offended, the compost is not good. Care should be taken that diseased plants do not find their way into the heap—there is no better way of spreading plant diseases than through a compost heap. One last caution. If you make compost, expect to have Rhinoceros Beetle inspectors tear it to pieces fairly frequently until such time as you get it underground—compost heaps provide first class accommodation for the grub stages of the beetle. If, however, you are making compost properly, you should have at least three bins in a row so that at the first turning, compost is moved from bin 1 to bin 2, and at the second turning from bin 2 to bin 3, and one way and another you should be able to get a free turn from the Rhinoceros Beetle boys when they call.

Use fertilizers as recommended above in addition to compost or animal manure.

Blood and Bone.—This is a good general purpose fertilizer. If used in sufficient quantity it will to a large extent replace the fertilizers recommended above. It is, however, more costly lb for lb of plant food supplied. On this basis blood and bone is about half as dear again as an equivalent ammonium sulphate-superphosphate mixture, and furthermore, contains virtually no potassium. It does supply organic matter which is lacking from inorganic mixtures, and if preferred, or where it is better for some reason to use blood and bone, it should be applied at about twice the rates given per acre or per yard of row for the complete mixtures above. Potash should be added at the rate of about 1 oz per lb of blood and bone for a complete NPK fertilizer.

Lime.—In most parts of Fiji, except where soils are formed on old, raised coral beaches or reef, or on or near limestone deposits, agricultural lime should be applied. Optimum rates will vary from place to place and will depend sometimes on the crop being grown. Amounts from 1 to 2 tons per acre will be safe in most cases (equals ½ to 1 lb per square yard) as an initial dressing, with further additions of 6 to 7 cwt per acre per year (about 3 oz per square yard) thereafter. Depending on the ease of availability of lime and the type of farming it will sometimes be more practicable to put on a ton per acre every three years than to topdress with lime each year, but where the land is being worked for annual crops lime should be added at shorter intervals for best results.

Agricultural lime (simply crushed limestone) is the best form to use if available. If agricultural lime is not available, coral sand should be used at three or four times the rate recommended for crushed lime. Coral sand is too coarse to have a rapid effect in most circumstances, and will often take a year or more to produce any effect on soil acidity. Burnt lime may be used either slaked or unslaked. Either of these forms is much more costly than agricultural lime. There is no essential difference between any of the different forms of lime except that coral sand is very slow acting because of its coarseness, and both slaked and unslaked limes are very rapid acting, and because of the costs of burning, and, for slaked lime, slaking, are dear compared with agricultural lime, which reacts with soil at an intermediate rate.

Storage.—Superphosphate and basic slag may be stored in cloth or paper bags, or in wooden or concrete bins. *Keep dry or they will cake and may have to be reground.* If bags get damp and cake, the contents can often be broken up again by dumping the bags on a *dry* place. Make sure the bags are sound before dumping.

Ammonium sulphate and potassium sulphate should always be stored in cloth bags, never in paper or wooden containers. Bags should be stored on raised, slatted platforms in small, loose stacks. Platforms should be at least a foot above the ground or floor, and stacks must be kept at least nine inches away from walls, so that there is free circulation of air under and around stacks. These materials will usually cake with moisture taken up from the atmosphere, but can be shattered by dumping. It is of the utmost

importance to keep ammonium sulphate and potassium sulphate dry, because both are soluble in water and will run out of the bag if allowed to become wetter than they will normally do by absorbing moisture from the air.

Mix fertilizers on a good wooden or concrete floor. Always clean up thoroughly after mixing. Take particular care that fertilizers do not get spilt on or near machinery or other metal—most fertilizers will corrode metal very rapidly.

In general, the soils of Fiji are not fertile and will respond to correct additions of fertilizers and probably to liming. As a rough guide it may be said that :—

(*a*) Green leaf crops need nitrogen in particular.

(*b*) Seed crops (beans, etc.) need phosphorus in particular.

(*c*) Root crops need potash perhaps more than most other crops.

This is not to say that one fertilizer alone will suffice in any case, but rather that nitrogen should be higher in a fertilizer mixture for green-leaf crops than for others, phosphorous higher in a mixture for seed crops than for others, and potassium higher in mixtures for root crops than for others.

Basic slag may be used instead of superphosphate—in the same amounts given in the mixtures above. It costs more, but will often supply plants with more phosphorus over a longer period than an equal amount of superphosphate. *If basic slag is used it must never be mixed with ammonium sulphate.* Either may be mixed with potassium sulphate and the other applied separately to the ground a few days before or after the mixture is applied.

Liming acid soils seems almost invariably to increase the availability of soil phosphorus. Lime does not contain phosphorus, but helps release soil phosphorus from one or other of the "fixed" forms. Recent chemical analyses of rice plants in Fiji showed, amongst other things, that most of the plants grown on limed soil had higher phosphorus contents than those on unlimed soil under similar conditions.

It is impossible to cover any subject adequately in a short note like this. Recommendations for some crops have been left out because insufficient is known about them ; no mention has been made of the many different kinds of nitrogenous and other fertilizers available overseas and so on. Anyone seeking further information about any aspects of the subject should get in touch with the Department which will gladly supply any information available.

A NOTE ON ENGLISH POTATOES IN THE SUVA DISTRICT

By H. W. SIMMONDS, O.B.E.

The writer has grown English potatoes in his garden with a moderate amount of success for the past five years, in the Suva district. Certified stock being unobtainable in small quantities he has had to rely upon what he could pick up in the market for seed. These should be small and shewing eyes.

Do not use large ones cut, as these have been found to rot in the wet weather. Place the seed potatoes in a dark place on damp sawdust and cover with a damp cloth until growth starts.

Plants take about fourteen weeks to maturity, so that planting can be commenced towards the end of March and continued until the end of July, at say two weekly intervals.

It is advisable to use a certain amount of superphosphate when planting and much better results are obtained if a good dusting with sulphate of potash is applied at the same time. A watering with this as soon as the plants are just above ground also seems to help. The writer also gives a watering with sulphate of ammonia once or twice at the rate of one teaspoonful to the gallon, during growth.

They should be dug as soon as the haulm turns yellow or, in this wet climate, growth of the tubers may commence.

Whilst potatoes grown in Suva are not the mealy ones grown in temperate climates, nor are they as large, they come in at a season when imported ones are not too good and add a useful item to the dining table.

RICE SURVEY 1954/55

(1953/54 Figures in Brackets.)

	GROWERS				ACREAGE			
	Indian	Fijian	Others	Total	Indian	Fijian	Others	Total
SOUTH—								
Serua	339 (410)	11 (10)	....	350 (420)	1218·1 (1028·5)	19 (11)	....	1237·1 (1039·5)
Namosi	3 (53)	.. (1)	....	3 (54)	6·5 (81)	.... (1·5)	....	6·5 (82·5)
Naitasiri	313 (109)	12 (5)	.. (6)	325 (120)	502·4 (233·1)	14·3 (23·3)	.. (24·5)	516·7 (280·9)
Lomaiviti	6 (12)	9 (24)	.. (2)	15 (38)	19·2 (12)	8·5 (33·7)	.. (2)	27·7 (47·7)
Tailevu	208 (242)	131 (141)	2 (8)	341 (391)	960·6 (774·5)	278·6 (251·6)	8·5 (82)	1247·7 (1108·1)
Rewa	186 (93)	18 (15)	3 (2)	207 (110)	184·5 (136·2)	29·3 (23·4)	3 (1)	216·8 (160·6)
Cane Growers ..	1897 (1640)	14 (29)	1	1912 (1669)	3058 (2665)	19 (43)	1	3078 (2708)
	2952 (2559)	195 (225)	6 (18)	3153 (2802)	5949·3 (4930·3)	368·7 (387·5)	12·5 (109·5)	6330·5 (5427·3)
NORTH—								
Macuata	591 (721)	45 (61)	.. (9)	636 (791)	2837 (3128)	135 (104·5)	.. (16·8)	2972 (3249·3)
Cakaudrove ..	39 (39)	20 (23)	1 (4)	60 (66)	119 (122·5)	46 (47)	4 (18·5)	169·4 (188)
Bua	245 (252)	34 (76)	.. (1)	279 (329)	1344 (1525·2)	88 (262·6)	.. (10)	1432 (1797·8)
Cane Growers ..	2744 (2648)	6 (4)	....	2750 (2652)	5033 (4755·5)	8 (11)	....	5041 (4766·5)
	3619 (3660)	105 (164)	1 (14)	3725 (3838)	9333 (9531·2)	277 (425·1)	4 (45·3)	9614·4(10001·6)
WEST—								
Nadroga/Navosa ..	429 (519)	191 (237)	3 (3)	623 (759)	1527·5 (1618·7)	401·6 (401·6)	11 (11)	1940·1 (2031·3)
Ra	307 (307)	52 (52)	1 (1)	360 (360)	1061·25(1061·25)	92·25(92·25)	1 (1)	1154·5 (1154·5)
Ba	680 (675)	93 (65)	....	773 (740)	2764 (2578·25)	301 (227)	....	3065 (2805·25)
Cane Growers ..	7265 (7431)	171 (218)	14 (7)	7450 (7656)	12643 (13154·5)	280 (369·5)	26·5 (22)	12949·5 (13546)
	8681 (8932)	507 (572)	18 (11)	9206 (9515)	17995·75(18412·7)	1074·85 (1090·35)	38·5 (34)	19109·1 (19537·05)

SUMMARY—

	Growers.	Acreage
South	3153 (2802)	6330 (5427)
North	3725 (3838)	9614·4 (1000·1)
West	9206 (9515)	19109 (19537)
	16084 (16155)	35053·4 (34965)

ACREAGES—1951/52—35235
1952/53—36640
1953/54—34965
1954/55—35053

Note.—Cakaudrove figures do not include Taveuni and Wailevu while Macuata figures exclude Dogotuki.

RICE SURVEY 1954/55—VARIETIES

Variety	Ra	Ba	Nadroga	Serua	Namosi	Rewa	Tailevu	Lomaiviti	Naitasiri	Macuata	Cakaudrove	Bua	Cane Growers			Total	Approx. per cent of total	Variety
													West	South	North			
Bandala ..	289	820	405	....	....	....	....	....	....	....	....	....	774·5	....	....	2288·5	6·5	Bandala
B.G. 75 ..	9·75	55	·2	....	....	....	2	1·3	1·5	....	....	....	64	29	....	161·75	....	B.G. 75
B.G. 79 ..	15·5	160	2·5	....	....	....	....	....	18·6	....	....	....	....	....	....	196·6	....	B.G. 79
Bichera ..	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	Bichera
China Patna ..	126	133	11·5	129·5	....	110·4	167·8	·5	44·3	155·5	5·9	181	1537·5	709	328	3639·9	10·4	China Patna
Karia ..	4	25	48·2	4	....	·3	2	....	1·4	5·5	....	....	21	1	505	617·4	1·7	Karia
Lautoka ..	....	93	....	....	....	....	....	....	....	9·5	....	8·5	27	....	122	260	....	Lautoka
Kuthmuria	67·75	675	51·7	....	....	....	....	·5	....	....	....	....	2161	....	....	2955·45	8·4	Kuthmuria
Motka ..	....	7	122·5	8·5	....	3·5	2	....	5·	309	....	119·5	1941·75	....	590	3104·25	9	Motka
New Guinea .	144	60	336	920·2	4·5	37·7	683·7	1·5	225·9	342	85·5	139	264·5	1220	937	5371·5	15·3	New Guinea
Patarka ..	190·5	90	263·8	7·8	2	3·2	123·8	3·7	16·5	....	....	....	306	7	61	1075·3	3	Patarka
Ramkajara	262·25	95	62·8	128·5	....	59·9	240·4	19·7	165·5	1828	78	645·5	798·5	797	2112	7293·05	20·8	Ramkajara
Rewa Patna ..	....	....	64·3	13·6	....	....	15	....	34·5	....	....	....	2·95	242	8	406·9	....	Rewa Patna
Saraya ..	69	760	58·3	19·5	....	....	11	....	5·5	....	....	....	4142·75	15	97	5178·05	14·8	Saraya
Sona Calif	7·75	....	231·1	....	....	....	....	....	....	12	....	....	10	....	90	350·85	1	Sona Calif
Gaji ..	....	....	3	....	....	....	....	....	....	....	....	....	37	....	12	52	....	Gaji
Sugji ..	....	65	4	....	....	....	....	....	....	....	....	....	....	....	162	231	....	Sugji
Mohi ..	....	24	....	....	....	....	....	....	....	....	....	....	....	....	17	41	....	Mohi
Gaji (Chetur)	....	3	....	2	....	....	....	....	....	....	....	....	....	....	....	5	....	Gaji (Chetur)
D116 ..	....	....	....	3·5	....	1·8	....	1	·5	....	....	....	....	2	....	8·8	....	D116
Bhasmati .	....	....	....	....	....	....	....	....	2	15·5	....	8	....	46	....	71·5	....	Bhasmati
Ram Bhog	....	....	40·2	....	....	....	....	....	....	....	....	....	45	....	....	85·2	....	Ram Bhog
Patna ..	....	....	234·9	....	....	....	....	....	....	....	....	....	14	10	....	258·9	....	Patna
Jhinwa ..	....	....	....	....	....	....	....	....	....	240·5	....	107·5	....	....	....	348	1	Lakharawa
Lakharawa	....	....	....	....	....	....	....	....	....	....	....	....	147	....	....	147	....	Lakharawa
Benzin ..	....	....	....	....	....	....	....	....	....	....	....	....	138	....	....	138	....	Ben,,
Tonkuwa .	....	....	....	....	....	....	....	....	....	....	....	....	159	....	....	159	....	Tonkuwa
Bigan ..	....	....	....	....	....	....	....	....	....	....	....	....	184	....	....	184	....	Bigan
Japoni ..	....	....	....	....	....	....	....	....	....	54·5	....	223	....	....	....	277·5	....	Japoni
Others ..	....	....	·2	....	....	....	....	....	....	....	....	....	147·5	....	....	147·7	....	Others
TOTALS	1154·5	3065	1940·2	1237·1	6·5	216·8	1247·7	27·7	516·7	2971	169·4	1432	12949·5	3078	5041	35053		TOTALS

ANIMAL HUSBANDRY . . .

NOTES ON POINTS IN SELECTING A GOOD MILKING COW

Local farmers and individual cow owners throughout the Colony will sometimes find it difficult to make up their minds as to what breed and type of cow to select as a good milker.

The Department of Agriculture for many years through legislative measures has been trying very hard to improve the livestock in this Colony (Stock Improvement Ordinance) and results are showing. With the improvement and grading of our livestock, there is no reason why a good milker cannot be obtained.

It is not necessary to select a pure bred cow to be a good milker. A good milker can be of any breed or colour. But one must remember and ought to know the good and the bad points.

When selecting a good milking cow it is essential to study the animal carefully, both from a distance and also close up.

The following points should be observed. When looking at a cow from the side it should have the appearance of being distinctly wedge-shaped, and should be fairly low set. It is rather important that she should broaden out from the shoulders to the hindquarters. The view from the front should be narrow at the withers and wide across the chest—another wedge. While looking from top it should widen out from the withers to the hip bones, having a flat back and well sprung ribs.

A good cow is always chewing the cud when not eating and sleeping. This is a good sign, which indicates good digestion and formation of good rich blood. She should be active, alert, not nervy and fretful and must not be a slow moving animal.

While examining it closely the following points should be noted: —The udder should be large and wide, and run well up between the hind legs. On feeling, it should be elastic and pliable, firm when full of milk, but loose and not fleshy when empty. The touch should be soft and silky. Fullsized teats should be evenly placed on each of the four quarters of the udder. The surface of the udder should show a number of small veins, and a prominent milk vein should be clearly seen along the belly.

The skin should feel loose and elastic and well covered with fine hair, free from excessive fleshiness.

More details on closer examinations are as follows :—The head should be broad and full across the fore-head with large, prominent, alert eyes. The face should not be too short, it should be lean and straight or slightly dished. The muzzle should be clean and strong with large open nostrils and wide firm mouth. Horns if present should be fine and not too large. The shape and curving will depend on the breed. The neck should be long and thin and flat at the side, with a clean-cut throat and light dewlap.

The chest should be broad and strong but not fleshy, narrow and light at the withers and with sloping shoulders.

The back-bone should have a lean open jointed chine with prominent vertebræ. It would continue along the tail and terminate at the level of the hocks. The ribs should be well sprung, sloping back and well spaced to enable two fingers to lie between them. The loin should be broad and strong.

The belly should be broad and deep with a large strong navel. Examining it from the back, the hip should be noted first, this should be wide apart and separated by a strong pelvic arch. A dropped hindquarters is a distinct weakness in a good milking cow. The rump from the hip bones to pin bones should be broad and long.

The hind legs should be lean, straight and wide apart. The flanks must not be fleshy.

Finally the tail should be long, not fleshy or coarse, and should terminate with a good switch of fine hair.

—F. M. FATIAKI.

LAND USE AND DEVELOPMENT . . .

PRICKLY SOLANUM—KAUSONI SOLANUM TORVUM SWARTZ

A DECLARED NOXIOUS WEED

Prickly Solanum is a declared primary noxious weed throughout the islands of Vanua Levu, Taveuni and Kadavu. Throughout the other islands of the Colony it is declared a secondary noxious weed. The species is a recognised pest of pastoral, agricultural and plantation lands.

Prickly Solanum is a green, erect shrub attaining a height of eight to ten feet, armed with large, curved thorns and having young stems and leaves which are somewhat roughened with fine hairlike spines. The flowers are small and white with a yellow centre. The fruit forms in clusters, each one being smooth, yellowish green and slightly oval in shape.

BOTANICAL DESCRIPTION.

Solanum torvum Swartz. *Family* : *Solanaceæ.*

Common Names : **Prickly Solanum ; Kausoni (F).**

A hard, erect shrub up to 8 or 10 feet (2.4 to 3 m) high, stems and pedicels tomentose with sharp, pointed, flattened spines. Leaves more or less elliptic, large, 4 to 7 inches (10 to 18 cm) long and 3 to 5 inches (7.5 to 13 cm) wide, slightly pubescent on lower surface, rough on upper surface and often with one flattened spine on the midrib near the base on the lower surface of the leaf. Lilac coloured flowers given off in corymbs at intervals on the branches, peduncle fairly short, pedicels approximately $\frac{3}{8}$ inch (1 cm) long. Corolla approximately $\frac{3}{8}$ inch (1 cm) long, calyx about 3/16 inch (4 mm) long, lobes triangular, stamens 5, pistil 1 ; ovary 8-chambered. Fruit a yellow-green, smooth skinned berry about $\frac{3}{8}$ inch (1 cm) in diameter.

Solanum torvum was first recorded from the West Indies and described by Swartz in "Nova Genera and Species Plantarum", published between the years 1785-87. The date of its introduction to Fiji is not known but Greenwood states that it was common in parts of Fiji in 1906. It is thought to have reached Fiji from India where it is a common roadside weed. By 1926 it had spread to such an extent that the Noogoora Burr Ordinance was extended to include this plant. *Solanum torvum* has now been recorded from most parts of the Group and has become a prominent pest of pasture lands.

CONTROL.

The first step toward the control of Solanum is to prevent the spread by seed. To do this grubbing or herbicides may be employed.

Young plants up to two feet tall are controlled by spraying with 2, 4 Dichloroacetic acid at a rate of two pounds of acid equivalent per acre.

Large plants may be grubbed and the sucker growth sprayed with 2, 4 D esters at the rate of two pounds of acid equivalent per acre.

The spraying of large plants has not been entirely satisfactory owing to the difficulty of obtaining a complete coverage of all growing points. Where it is desired to spray large plants, kills may be obtained by using, 2, 4 Dichloroacetic acid esters at a rate of four pounds of acid equivalent per acre or 2, 4, 5-Trichloroacetic acid esters at three point six (3.6) pounds of acid equivalent per acre. It is important that the stems as well as the leaves be thoroughly covered with the spray. More than one spraying will be necessary and sites where plants have been allowed to seed should be kept under observation for a number of years.

—T.L.M. AND J.W.P.

REFERENCE.

Hutchinson J. and Dalziel J. M.—"Flora of West Tropical Africa", Volume II. Part I.

Prickly Solanum (Solanum torvum Swartz.) A Declared Noxious Weed. Habit of seedling ; flower ; fruit.

A NEW TECHNIQUE OF ASSESSING QUALITY OF COCOA

BY V. E. SILLS

By making use of a new method of fermenting small quantities of cocoa under carefully controlled laboratory conditions, it is now possible for the plant breeder to base his selection of clones on the manufacturer's assessment of chocolate flavour as well as on physical and botanical characteristics.

During the past few years efforts have been made to expand the world production of cocoa by increasing the areas already under cultivation and by encouraging the planting of new areas where little or no cocoa has previously been grown. Fiji naturally falls into the latter category and we are now at the stage of selecting and propagating what we believe to be the most suitable kinds of cocoa. Since a cocoa plantation is an expensive undertaking it is important to know from the start that when the tree comes into bearing the quantity and quality of the cocoa produced per acre will be high enough to make the enterprise profitable. It is hoped that the new technique about to be described will help the producer to arrive at this satisfactory position.

In the Fiji Islands there are many established cocoa trees in existence. The majority of these have been neglected for many years and are to be found in isolated spots throughout the Colony, while others appear singly or in groups in gardens or on estates. Cocoa nurseries are in being at the Plant Introduction and Quarantine Station, Naduruloulou, and at the Principal Agricultural Station, Koronivia, and also at several other centres. The varietal characteristics of the cocoa found throughout the Islands are extremely diverse, ranging from pure Criollo to Criollo-Forastero hybrids and pure Forastero. Unfortunately, very little is known about the quality of the cocoa produced by the different trees since there has not at any time been sufficient weight of crop to justify commercial exploitation.

It is pleasing to record, however, that during the past three months some very useful knowledge of cocoa quality from a small number of selected trees has been gleaned from tests conducted in the chemical laboratories using a new technique of fermenting the contents of a single cocoa pod. The method is described in detail by Wadsworth and Howat(1) of the Research Laboratories of Messrs. Cadbury Brothers Limited, Bourneville, in a paper published in August, 1954. By using this method it is possible to obtain well fermented beans comparable with those produced by the best estate practices. To obtain a reliable assessment of cocoa quality the beans are dried and sent by airmail to one of the larger chocolate firms equipped with the necessary trained staff and an experienced panel of expert tasters. The true quality can than be expressed in terms of chocolate flavour. Hitherto it has been necessary to send commercial quantities of cocoa to the chocolate maker in order to determine quality and value ; and even then the results have been by no means satisfactory. The advantages of the new technique requiring only one pod per test are clearly evident.

Care is needed in the selection of cocoa for testing in the laboratory. For example, one of the most important characteristics is its bearing capacity. Low or high yielding capacity appears to be an inherent characteristic of cocoa and therefore it is important to choose only those cocoas which are known to be produced from good or heavy bearers. Secondly, the weight and number of seeds in the pod are important. Pods containing a heavy content of seeds should be selected from high yielding trees where possible, and small seeds—those which weigh less than one gramme when fermented and dried—should be avoided. Small beans are not liked by the chocolate makers because of the difficulties experienced in the factory during the operations of crushing the roasted beans between rollers and of separat-

Plate 1 : Aseptic Fermentation. A beaker containing the seeds from one pod.

ing the shell from the nibs. Thirdly only freshly cut ripe pods—pods whose contents may be heard to rattle when shaken vigorously—should be used for testing and there should be no evidence of germination within the pod. The cocoa should also, of course, be entirely free from any defects relating to attack by insects or disease organisms.

Briefly the laboratory fermentation technique is as follows : The selected pod is washed and dried preparatory to the opening of the pod and removal of seeds. This is desirable because, unlike the commercial practice of promoting natural fermentation with wild yeasts and bacteria, the laboratory method depends for its success on the suppression or elimination of all micro-organisms of fermentation. The seeds are carefully maintained in a sterile condition throughout the test and the heat of fermentation normally derived by plantation curing processes is substituted by artificially supplied heat from an electrically heated cabinet or incubator whose temperature can be regulated within the limits desired. The clean pod is cut open along its longitudinal axis with a sterile knife and the contents

are carefully transferred to a sterile 600 ml tall beaker containing a false bottom consisting of an inverted porcelain or silica dish. (Plate 1). The latter is mounted on a second but smaller dish, itself resting on the bottom of the beaker and containing a small quantity of caustic potash. The false bottom prevents the seeds from entering any liquid which subsequently seeps away and collects in the bottom of the beaker. The caustic potash absorbs carbon dioxide gas which is given off by the seeds during incubation or "aseptic" fermentation. Removal of carbon dioxide is important because the seeds do not develop the basis of a normal chocolate character if the gas is not removed. As regards the fermentation of cocoa on commercial lines, the gas is effectively removed by turning the fermenting mass over mechanically or by hand at least once each day.

Having transferred the seeds to the beaker as described above the seeds are then sprayed with a harmless antiseptic solution to prevent the growth of any organisms which may inadvertently have gained access either from the air or from the pod wall. The beaker is finally sealed with a double thickness of aluminium foil and placed in an incubator set at a constant temperature of 35°C. This temperature is maintained for 3½ days after which it is changed to 50°C and kept at this figure for a further three days. The fully fermented beans are then removed from the beaker and dried artificially at a slow rate.

The purpose of the first stage of aseptic fermentation at 35°C is to cause changes to take place within the seeds akin to germination. The seeds lose some of their original bitterness and astringency and develop a mild flavour which is later to form the basis of a chocolate flavour. The seeds become plump and colour changes occur in the cotyledons. Carbon dioxide is evolved in appreciable quantities but this is quickly absorbed by the caustic potash present.

The second stage of the process is designed to kill the seed and to bring to an end the natural biochemical changes which occur in the living tissues during germination. At the higher temperature the evolution of carbon dioxide soon ceases and certain other chemical changes take place, mainly of an oxidative character, whose chemistry is still not perfectly understood. The development of what ultimately becomes the chocolate flavour of the roasted bean is then more or less complete.

The plantation method of curing cocoa is similar in principle to the laboratory method just described. The commencement of natural fermentation is accompanied by a rise in temperature, and while the rate at which heat is produced depends a good deal on the design of the fermentary and management thereof, the temperature should reach 35°C within 24 hours and approximately 50°C after a further interval of two or three days. Aeration is essential during this period and some means of stirring the fermenting mass once per day is usually found. The fermentation of the sweet pulp surrounding the seeds is essentially alcoholic in the preliminary stage and acetic (vinegary) and lactic (sour) during the later stages. The high temperature remains fairly constant for a short time and then slowly falls. In all the fermentation lasts for six or seven days, the variety of cocoa deciding the actual time. The fine cocoas, of which the world supplies are small, need only two or three days of fermentation, but this is the exception rather than the rule with most cocoas.

It will be noted that the laboratory method of curing cocoa does not get rid of the sticky pulp, and the latter adheres to the seeds right up to the point of final drying. Its presence is comparatively unimportant, however, because although it retards the drying process it does not affect the determination of chocolate flavour. In fact, slow drying of the freshly fermented beans is advantageous provided it is not so slow as to permit mould growth. The plantation or fermentary methods of curing cocoa, on the other hand, do get rid of the objectional pulp. The beans are therefore relatively easy to dry and not easily spoiled by mould when stored in readiness for export. At the end of the allotted span of incubation in the laboratory the seeds are found to have darkened to a characteristic brown colour and to have become more plump. When

the fermented seeds or beans are taken out of the beaker care is taken to avoid contact with caustic potash solution and to reject any which have accidentally been immersed in liquid during any part of the fermentation. The beans are not washed but are immediately spread out on a warm surface to dry ; drying should be extended over two or three days. Sun drying may be practised on a plantation scale in countries where climatic conditions are favourable, but the prospects of successful drying by this method in Fiji are very slight and recourse to an alternative artificial method of drying will have to be made.

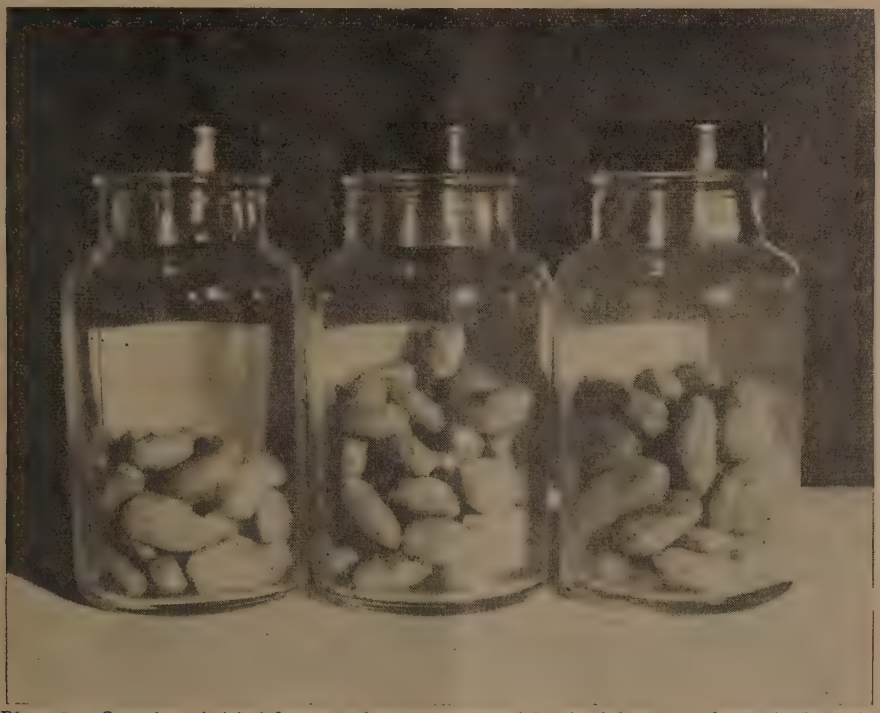

Plate 2 : Samples of dried fermented cocoa prepared in the laboratory from single pods.

The final operation is to sort over the beans, removing any shrivelled or undersized specimens, and to send them by airmail to a chocolate firm for quality assessment. There a small sample of chocolate is prepared from the cocoa after it has been carefully roasted, and a panel of expert tasters judge and compare the flavour with that of a standard sample of chocolate prepared from say a good average quality West African cocoa. The complete operation, starting with the fermentation and concluding with the receipt by us of a report on quality, has usually taken less than six weeks—a remarkable improvement on the costly and cumbersome procedure of sending commercial parcels.

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THE USE OF CARTONS IN MILK DISTRIBUTION

BY W. J. A. PAYNE

Milk distribution is conducted under somewhat primitive conditions in Fiji as at present there is no refrigeration or pasteurisation. Milk is usually retailed from closed buckets and milk dilution is so common as to be almost normal. The honest producer-retailer who depends on hired labour cannot stop his labour from diluting milk distributed from a bucket and for the dishonest it is the normal habit. When milk is diluted it is usually done secretively and polluted water may be used, so that diluted milk is a positive health menace.

One method of preventing the dilution of milk during distribution is to package it at the dairy or milk collecting centre. This will not prevent the dishonest producer from diluting milk but dilution by the producer can more easily be prevented than dilution by the distributor. If the milk is properly packaged it is impossible to dilute it during distribution without the consumer finding out. Packaging also has other advantages. It is more hygenic as there can be no dust contamination, it is quicker and easier to distribute so that costs are lower, and packaged milk is more attractive to the consumer. The only major disadvantages of packaging are the initial cost of packages and the capital cost of the equipment used for packaging.

Milk can be packaged either in bottles or in waxed paper cartons. Overseas most milk is bottled, but in the United States waxed paper cartons are widely used and in the United Kingdom, Scandinavia and Australia cartons are used to a limited extent and

Plate 1 : A hand sealing device. The carton is filled with the correct quantity of milk, folded by hand, the metal clip placed in position, and sealed.

their use is increasing. Bottles are initially more expensive to purchase but can be used again and again until they are broken. They must be sterilized before use and this means either the installation of expensive bottle washing machinery or the use of additional labour. A major disadvantage of bottling milk in Fiji is that consumers use the bottles for all kinds of purposes for which the bottles were not intended. Consequently washing costs are higher than they would be overseas. One producer-retailer in Fiji who is bottling his milk has found it very difficult to maintain standards of cleanliness that satisfy the local health authorities.

The alternative to bottling, that is packaging the milk in waxed paper cartons, is being tried at Sigatoka Agricultural Station.

Plate 1. No refrigeration plant is yet available and the milk is packed in the cartons immediately after milking and distributed in the Sigatoka district as quickly as possible. No more than one hour lapses between milking and the end of distribution.

Distribution is very simple. The cartons are packed in wire baskets and are left on doorsteps or at distribution points. Before packaging was instituted, milk was distributed from a can carried on a tricycle and there were frequent complaints from the consumers of alleged dilution by the distributor and in addition the milk was often sour before distribution ended at 10.30 a.m. To-day distribution is completed by 6.30 a.m., and complaints from consumers are virtually non-existent. The main expense of distribution is the purchase of

Plate 2 : Two simple machines used for sealing cartons at Sigatoka. The carton is placed in the machine on the right and filled with the correct quantity of milk, a lever operated by the right hand folds the top of the carton correctly. It is then taken out of the folding machine using the left hand, a metal clip is placed in position with the right hand and the carton placed in position in the foot operated sealing machine. The carton is then sealed and packed in wire baskets ready for distribution.

waxed paper cartons. These have to be imported and pint cartons from the United Kingdom cost approximatey three half pence each when imported in large numbers. Machinery to manufacture cartons could be installed in a large dairy plant but this is not economic on a small scale. It has been found at Sigatoka that the consumer is quite willing to pay for the additional cost of the carton if he knows that he is going to obtain undiluted milk of superior quality. Since milk has been distributed in cartons the sales have increased. The cartons can also be used to package cream, but are not suitable for the packaging of ghee.

The sealing of the cartons is done with the assistance of two simple machines illustrated in Plate 2. One machine holds and folds the top of the carton after filling and the other, a foot operated machine, seals the carton after the top has been folded. The capital cost of these two small machines is F£36 and one operator using them can fill, seal and pack in wire crates 360 pints of milk per hour. At a large dairy automatic machinery that fills and seals at the rate of 1,000 pints of milk per hour, and is operated by one man, can be used.

If a new dairy is planned, the use of cartons rather than bottles can affect major savings in capital outlay. Expensive bottle washing machinery is dispensed with and the amount of floor space required and hence the size of the building is much reduced. 1,000 empty cartons packed for use occupy 1.5 square feet of floor space and weigh 64 pounds while 1,000 bottles in crates occupy 15 square feet of floor space and weigh 1,305 pounds. The collection and checking of bottles also increases the labour required in distribution and administration.

It is concluded from experience at Sigatoka that producer-retailers or groups of producers contemplating the distribution of milk should examine very carefully the advantages of the use of waxed paper cartons in Fiji. At present the cost of the carton represents 16 to 20 per cent of the retail cost of the milk ; but as the cost of milk increases, and if the cartons are ordered in large enough quantites, the relative cost of the carton should fall. In addition there are subsantial capital and administrative savings to be made if cartons rather than bottles are used for packaging milk.

OBITUARY

H. M. STUTCHBURY, B.V.Sc.

It was with the deepest regret that officers of the Department received the news that Mr. H. M. Stutchbury had been murdered by Masai tribesmen. " Stuch " as he was familiarly called, joined the Veterinary Division of the Fiji Department of Agriculture on 15th September, 1928, and left on transfer to Tanganyika in 1938. He is remembered by his colleagues and by the farming community in Fiji as a skilled veterinary surgeon and an officer with an excellent practical approach to livestock problems.

During his service in Fiji he contributed to this Journal a number of articles dealing with the progress of the dairying industry in Fiji, animal foodstuffs and animal diseases.

He was later transferred to Nyasaland where he was promoted to the post of Deputy Director Veterinary Services. The last time that the writer saw him was at Tabora in Tanganyika in 1945, when he had certainly been having a rough spin. In 1939 he was about due for long leave and had sent his wife and daughter to Melbourne intending to follow a few months later but the war broke out and he was unable to leave. Ten years passed and he had been unable to join them. It is particularly tragic that his death should have been at the hands of the Masai who, as cattle owners, had benefited much by his labours.

RESEARCH PROJECTS . . .

BOTANICAL INVESTIGATIONS IN FIJI

No field of research and development has received less official attention locally in the past, than that branch of biology concerned with the study of indigenous and exotic vegetation which is generally recognised as the fundamental basis both for the protection of natural resources and also for the development of plant-dependent industries such as agriculture, forestry and animal husbandry. For upwards of fifty years, the agricultural research and extension services in the colony have had to rely for such information largely on the spasmodic reports of visiting botanists or on the contributions made by local often unpaid workers. Not only were the results of botanical research published in overseas scientific journals not always available; but also the collections and reference material made by overseas investigators were all stored in institutions

Plate 1.—Botanical Research Laboratory, 1953.

far beyond the reach of the local worker entrusted with the practical task of planning and instituting land-use developments. Without this information the latter could proceed only in a largely empirical basis of general observation and experience. That the need for action was recognised may be assumed. For example, in 1938 there appeared a paragraph in *Nature** which read :—

" In connection with the movement for the preservation of the fauna and flora of the Empire, attention has been drawn to the imperfection of our knowledge of the flora and fauna of Fiji and of the Western Pacific High Commission territories "; and naturalists who were desirous of devoting a few months to such studies in these territories were advised to consult the Colonial Office.

* Nature, Vol. 141, No. 3564, p. 325—19th February, 1938.

No action resulted. World War II intervened ; and it was not until 1946 that the offer of generous grants for research under the Colonial Development and Welfare Scheme, provided an opportunity to make a start. In that year, the Fiji and Western Pacific High Commission Research Council recommended that an application be made for assistance from the Colonial Development and Welfare grants for the purpose of Agricultural Research. Three proposals were made covering the preliminary essential aspects of biochemical, botanical and plant disease research to be carried out in the Colony of Fiji and the territories of the Western Pacific High Commission.

Although these projects were approved in principle in 1947, it was not until 1954, that final approval was obtained. The sum of £12,650 was made available for the botanical investigations which were to cover the following fields :—

Collection determination and description of the grasses, weeds and legumes of the Colony and the Western Pacific High Commission territories and the preparation of a

Plate 2.—Botanical Research Laboratory—interior view showing general lay-out.

Bulletin describing the species, illustrating those of economic importance and giving up-to-date information on their value either for animal nutrition or for other uses.

The grant provided for the building of a Laboratory and Herbarium, the renovation of quarters, the purchase of equipment and the appointment of staff. The building, completed in 1953, is a substantial concrete one comprising a large room for the herbarium, a small office-cum-laboratory and a preparation room. (Plate 1). Furnishings include an electric specimen drier, special racks and cupboards for storage of specimens and large bench-tables for the easy handling of material. (Plate 2).

Standard equipment, including microscope, microtome and embedding oven has been provided ; and by a fortunate circumstance it was possible to acquire a valuable collection of botanical reference books for the laboratory library. The departmental

collections brought together over the past twenty years are thus at last adequately housed and available for study. They have been examined, fumigated, remounted and tentatively classified and indexed.

In the terms of the approved programme, the Assistant Botanist, who assumed duty in November, 1953, is concentrating on the study of grasses, legumes, weeds and economic species, including some medicinal plants, and has collected widely during the year.

It is planned to prepare suitable bulletins for use in the Colony—as well as to provide a botanical advisory service for the general public—the schools and other institutions concerned with utilization of plants. As an indication of the need for these services, the following list of enquiries dealt with during 1954 is given :—

(*a*) Specimens received for identification—1074.

(*b*) Specimens collected—4300.

(*c*) Visitors (students and overseas)—450.

Similar studies on the weed species occurring in the region are in hand. The first bulletin dealing with the grasses of Fiji—indigenous exotic, has been completed and should be available early in 1956.

New Agricultural Publication . . .

THE GRASSES OF FIJI

by J. W. PARHAM, B.Sc.

A Bulletin describing the grasses so far recorded in Fiji is to be published shortly and will be on sale at the Department of Agriculture.

The Bulletin contains botanical and general descriptions of the grasses of the Colony together with notes on the distribution and usefulness of each grass. There are sixty-one line drawings and twelve photographs. The book comprises 176 pages and is priced at 5s. per copy.

Copies should be available by February this year and advance orders may be sent to the Director of Agriculture, Suva.

MECHANISATION.

(*Continued from page 73*).

" 20 " was converted from narrow to wide track setting (29½ to 44 inches centres) to enable 18 inch hardwood blocks to be fitted. Thus equipped, the Bristol was excellent for working on land which had been roughly disc ploughed and had then become waterlogged ; in these conditions wheels tended to get stuck in the hollows and spin, while the tracks experienced no troubles. But wheels were found to be better where water was standing, especially if the weed growth was heavy as it tended to get caught up in the tractor.

In order to dry the padi, which in this unpredictable climate sometimes comes in actually dripping wet, a " Nu-way " in-sack grain driver has been installed. Air is heated by an oil-burning furnace and blown under a concrete platform, in which 40 holes are each covered with a metal grating and a sack of grain. The padi is thus dried in the sack. This installation has worked well and has saved a lot of anxiety about sun-drying in periods of unending rain.

Various winnowers have been tried at different times but the only one yet found to give 100 per cent separation of Murraina Grass. (*Ischæmum rugosum*) is the Baby " Bedford ". This machine is very easily cleaned, so can be used for small quantities of seed. Its output however is small.

VETERINARY . . . .

ULCERATIVE SPIROCHAETOSIS OF PIGS

BY A. F. S. OHMAN

Ulcerative spirochætosis has been found to exist in pigs in the Colony. Specimens obtained from an affected boar were submitted for pathological examination and the causal organism has been isolated. To date a definite diagnosis has been made on one property only. It may be more widely spread but a close watch is being maintained to resrict the movement of infected stock which could spread the disease.

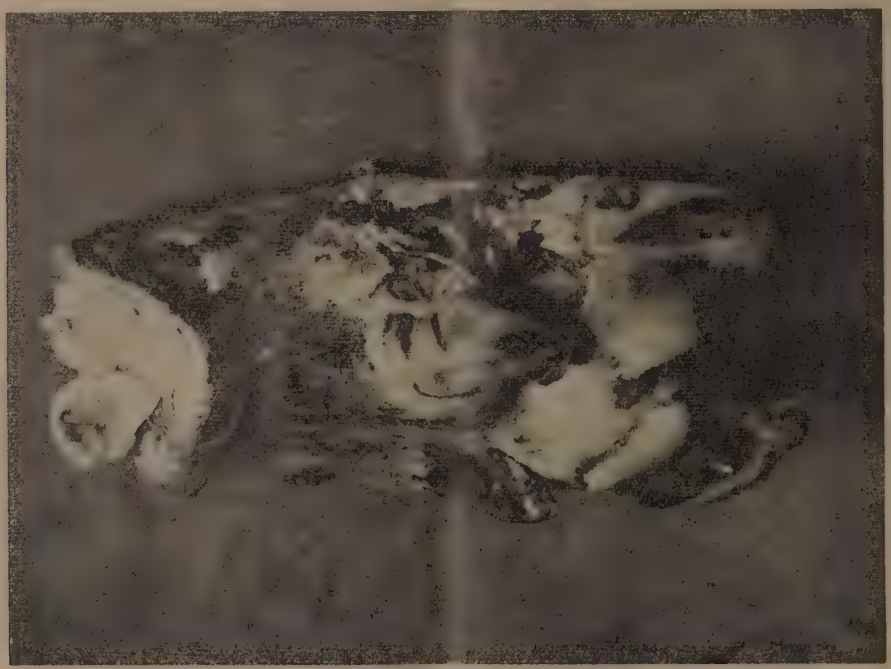

Plate 1 showing malformation of a front leg of a pig affected with spirochætosis.

Cause.—The causal agent, a spirochæte, is a spiral shaped organism, which can be seen only under a high powered microscope. It may be isolated from the superficial skin lesions of affected pigs. Infected material if rubbed into the scarified or broken skin of a healthy animal can reproduce similar cutaneous conditions.

Lesions and Course.—The organism usually gains entrance through skin abrasions. Firstly, a small swelling appears and gradually the part enlarges to an abscess formation which may burst to exude a greyish pus. Lesions can be extensive and up to 9" in diameter. In the present outbreak lameness was the initial sign of sickness and it was attributed to foot soreness associated with constant standing on concrete floors. In this Colony concrete floored sties are recommended in an effort to control kidney worm infection (*Stephanurus dentatus*). Mortalities may occur among young pigs but young pigs on the property were not affected. This was singularly fortunate because the organism may find entrance to the jaw when teeth are shed. Castration wounds are another common site for entry of the parasite.

Plate 2 showing infection on the under surface and in the horny tissue of the toe.

Methods of Control—

(1) Isolate affected pigs immediately the condition is suspected.

(2) Disinfect yards and troughs which have been occupied and used by infected animals.

(3) House pigs on concrete only and abandon dirty wallows and mud pools.

(4) Abandon the use of barbed wire in and about pig sties to avoid skin abrasions through which infection is made possible.

Treatment.—This consists firstly of the cleaning of the parts with an antiseptic solution, followed by the use of colloidal arsenicals or the use of antibiotics such as penicillin, both of which may be procured if supported by veterinary prescription.

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REVIEWS . . .

THE MANUFACTURE OF COPRA IN THE PACIFIC ISLANDS

BY W. V. D. PIERIS

TECHNICAL PAPER NO. 82—SOUTH PACIFIC COMMISSION

The latest publication by the South Pacific Commission on the subject of copra manufacture provides a welcome addition to our knowledge of this highly important industry, and Mr. Pieris is to be congratulated for the thoroughness with which he has conducted the work of surveying copra dryers and drying methods throughout the Pacific. The report is excellently written and is well illustrated with numerous photographs of specimens of copra, copra dryers, stores and so on, representative of practically every copra producing area.

The report is divided into four parts and begins with a botanical description of the coconut and an account of the commonly used methods of harvesting nuts. The variation in the quality of copra produced in different parts of the Pacific is clearly shown by means of photographs which include the finest "ball" copra peculiar to India and Ceylon and the worst examples of smoke dried cut copra from certain of the Pacific islands.

The title of the second part of the report is "Why produce copra of good quality?" The author presents a logical and convincing argument in favour of an all-round improvement in the quality of exportable copra from the Pacific region, beginning with a comparison of the future prospects of soap and edible grades of oil on the coconut oil market and concluding with an outline of the difficulties which the oil miller associates with poor quality copra contaminated with non-magnetic metals, stones and sand.

By far the largest proportion of Mr. Pieris's report appears in part 3 under the heading of "Copra dryers and drying methods." A prodigious amount of effort has been applied to the study of a considerable number of copra driers found scattered throughout the Pacific islands, and these are indeed remarkable for their extreme diversity in design, size and method of operation. The author proceeds to describe the many different ways of drying copra in the sun and concludes with the remark that sun drying is not to be recommended in the Pacific; even for small holders! A considerable amount of space is devoted to a description of the standard Ceylon dryer and its variants which depend for their efficient operation on the half-nut principle and the utilisation of dried shells as a sole source of fuel. The author believes that the introduction of this type of dryer into the Pacific Islands would result in an improvement in the quality of South Seas copra. Unfortunately, the widespread habit in Fiji and other Pacific Islands, of gouging pieces of coconut meat from the split whole nut makes it highly improbable that the Ceylon type dryer would be successful here—except perhaps under highly organised conditions. Hot air dryers of every conceivable shape and size are dealt with next at some length, prominent amongst which are those from Raratonga, Cook Islands and Western Samoa (New Zealand Reparation Estates). Finally there is a brief description of the Chula natural draught and forced draught models, few of which are to be found in the Pacific.

Mr. Pieris concludes his report by returning to the original theme of urging producers to concentrate on the production of better quality copra for which there will be a more assured market.

If one may be permitted to criticize this most interesting and informative publication it is merely to say that the author does not go far enough into certain important aspects of copra manufacture. For example, the vitally important subject of costs of production is scarcely touched upon and would have been worthy of a section to itself; and most producers would surely like to have more practical information on the working of patent hot-air dryers of the Chula type, since after all it is to this kind of development that we must now turn for the means of producing good quality copra on relatively small plantations. A final small, but by no means unimportant, criticism is the lack of an index. The reader who wishes to refer back to the text for information on dryers appearing in diagrams or photographs may experience some difficulty in locating the desired place. However, it may be stated without hesitation that all who are connected with the copra industry will find much to interest them in this publication, and it is to be hoped that the author's recommendations concerning the improvement of quality will receive widespread approval. —V.E.S.

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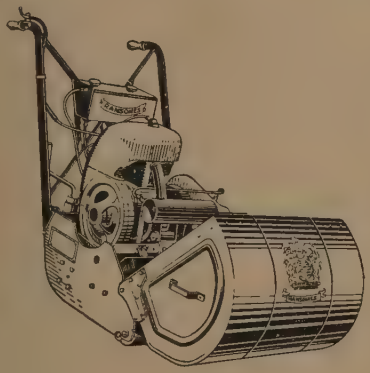

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ABSTRACTS . . .

TRACE ELEMENTS IN PLANT NUTRITION*

Early plant nutrition studies were made in water culture and those studies showed that at least six minerals were necessary for plant growth—sulphur, phosphorus, potash, magnesium, calcium, and iron. We now know that plants also require small quantities of boron, copper, zinc, iron, manganese and molybdenum.

Molybdenum is perhaps the most spectacular of the trace elements and is normally present in plant ash at levels up to 1 to 2 parts per million. This knowledge is now fairly general.

Scientists are constantly searching for additional essential elements. For instance vandium is now under attention as it has been shown to stimulate the growth of some lowly plant life.

RESEARCH.

Australia has been well to the fore in research on these trace or minor-elements. Deficiencies of copper, zinc, manganese and iron were all clearly demonstrated before 1940. However, we did appear still to have certain problem soils.

The work of Arnon and Stout in 1939 suggested a key to the problem and C.S.I.R.O. workers conclusively proved that molybdenum was deficient in some Australian soils.

Of local interest in New South Wales is work by A. J. Anderson of the C.S.I.R.O., Canberra, in which he demonstrated widespread molybdenum deficiency on acid soils of the Southern Tablelands.

Almost concurrently Waring and Wilson of the New South Wales Department established the fact that molybdenum deficiency was one of the main limiting factors in the growth of cauliflowers on acid soils. Subsequently molybdenum deficiency has been demonstrated on acid soils in a wide range of pasture and crop plants in New South Wales.

TRACE ELEMENTS.

The trace elements are required in very small amounts only and this distinguishes them from the " major " elements. With trace elements we tend to think in terms of pounds per acre instead of the cwts per acre usually concerned when dealing with the major elements. The trace elements appear to be very important as chemical " go betweens ". They do not enter very greatly into the actual composition of the plant but appear to be absolutely indispensable to its proper functioning.

Molybdenum is the trace element most widely deficient in New South Wales. Responses to molybdenum applications have been obtained at many centres on the Coast and on the Tablelands. This is perhaps one of the most spectacular of the trace elements in that results may be obtained from as little as 1/16-oz of the chemical per acre. Molybdenum appears indispensable to the nitrogen fixation process which takes place in the bacterial nodules on the roots of legumes.

Where a deficiency exists molybdenum may be absent or may be present in an unavailable form. Many of the responses due to applications of large quantities of lime have in fact been due to the effect of the lime in rendering molybdenum more available.

Molybdenum deficiencies have been recorded in New South Wales in such areas as the Southern Tablelands and the North Coast. Deficiencies in vegetable crops have been particularly evident in the Windsor area. At Taree deficiencies have been recorded in maize, cucurbits, pumpkins and lettuce. Symptoms of molybdenum deficiency resemble those of nitrogen shortage with pale yellow green leaves and poor growth.

Looking at it broadly we can say that without adequate mineral nutrition there can be no satisfactory legume growth. Without effective noduation of the roots of these legumes there can be no satisfactory nitrogen

fixation, and without this important source of free nitrogen, pasture plants exist in a state of starvation. Nitrogen fixation by legumes is the most important single process in soil fertility building.

PLANT MAKE-UP.

Let us summarize the make up of our plant especially the nature of its component parts, and the source from which these substances are derived. We often forget that more than 90 per cent of the weight of a plant comes from the air and from the water which is taken up by the plant roots. Less than 5 per cent of our plant comes from the minerals supplied by the soil.

Nevertheless, this small percentage of minerals is vitally important in the make up of and normal growth of a plant.

* Abstract from *Agric. Gazette N.S.W.*, December, 1954.

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THE HUNT FOR NEW FUNGICIDES*

Almost the greatest challenge which faces agricultural scientists to-day is that presented by the advance of the parasitic fungi. The trend of farming towards monoculture is a universal trend, which creates ideal conditions for the spread of fungoid diseases. In a field in which every wheat plant is genetically similar to its neighbours a fungus that can kill one plant will be capable of killing all the plants, and so the disease can sweep through a crop like fire spreading through a forest. The western world was taught a sharp lesson in the 1840s when Potato Blight brought famine to Ireland and drove huge numbers of Irishmen to emigrate across the Atlantic. To-day some scientists feel optimistic about the chances of halting the march of these fungi, and there is no denying that there are grounds for a reasonable modicum of optimism. Undoubtedly the range of effective fungicides is now much larger than it was a century ago, and it is likely to be extended within the next five or ten years. Yet it is salutary to remember that so far no perfect fungicide has been found for certain specific diseases, such as Panama Disease of bananas. The plant breeders and geneticists have had a fair measure of success in their efforts to produce new varieties with resistance to fungus diseases. But here again there is reason to be humble: little enough has been done to improve disease resistance in commercial plants—for example, there is no excuse to-day for rose growers to ignore modern genetics to the extent that they do and to market roses which are susceptible to mildew, and yet a high proportion of rose varieties in the catalogues have no resistance to mildew. This breeding for resistance is a real exercise in biological warfare, in which one can never be sure that a particular victory is a permanent one; there can exist many different strains of a pathogenic fungus and the variety of a crop plant which resists the attack of one particular strain may not be able to withstand the onslaught of another more virulent strain of the same fungus. This kind of thing has happened in the case of wheat rusts, and it seems that here the plant breeders must face the prospect of having to keep up a running fight against such diseases. The host parasite relationship in all such cases is a complex one and involves fundamental biochemical issues; when one considers the vast biochemical differences between, for example, all the different strains of a single fungus species such as *Penicillium notatum* and the capacity for mutation which the different strains possess (a mutation implies a substantial change in the basic biochemistry of the strain), one gets a hint of the magnitude of the problem of breeding a crop plant with a set of biochemical properties that renders the plant impenetrable by the hyphae of the attacking fungus or capable of smothering—by antibiosis—the hyphæ if they do succeed in penetrating the outer defences and reaching the more vulnerable internal tissues.

If the biochemists cannot as yet contribute anything substantial to the solution of these problems (which are, of course, very difficult because they are so complicated), the synthetic chemists are now busy producing new substances which show promise as fungicides and the biologists are testing them under field conditions. There is plenty of scope here, for the modern farmer has to rely very largely on a few fungicides which were developed a long time ago; some of these are quite satisfactory for certain purposes, but there is a good chance that better fungicides for general and specific uses will materialise.

An example of a good old remedy in current use is Bordeaux mixture, which is both cheap and efficacious. This is, of course, a fungicide containing copper which was introduced nearly seventy years ago. Copper fungicides were the first to be discovered. As long ago as 1761 Schulthuss steeped seed grain in a solution of copper sulphate to check smut and bunt which were ruining the cereal crops. In 1807 Prevost found that the growth of spores of bunt could be prevented by very small amounts of copper " even the amount which would be dissolved from a copper vessel by the water standing in it was sufficient ". He further

* Abstract from " Discovery " Vol. XV 1954.

demonstrated that a copper sulphate solution containing only 1 part of copper in 4 million parts of water poisoned these spores. Out of this observation developed the general practice of steeping cereal grains in copper sulphate solution. Sometimes the treatment was followed by the addition of lime in order to dry the grain. (It may be noted that this knowledge of the fungicidal power of copper sulphate was not exploited to stop the ravages of Potato Blight in the 1840s.)

A classic advance was made in 1885 when Millardet discovered that Bordeaux mixture was a cure for a fungus disease of the vine called Downy Mildew. This was the result of a lucky accident. He had spattered his vines with this mixture to deter people from "scrumping" his grapes, and found that it checked the depredations of the fungus as well as those of human beings! To-day Bordeaux mixture usually consists of about 1 per cent copper sulphate and 1 per cent quicklime, though a stronger mixture is usually used for vine mildew. (A convneient formula is 10 lb of copper sulphate and 12 lb hydrated lime added to 100 gallons of water. For the gardener, the equivalent formula reads 3 oz. copper sulphate and 4 oz. lime in 2 gallons of water; if you prefer to measure these materials with a tablespoon, the measures should be about 2 and 3 tablespoonfuls respectively.) Bordeaux mixture is used against scores of fungus diseases, including Potato Blight.

Other well-established copper fungicides are Burgundy mixture (a mixture of copper sulphate and sodium carbonate); and Chestnut compound, which is used in glasshouses and for seedlings, and which is made from copper sulphate and ammonium carbonate.

Another metallic ion which is very powerfully fungicidal is that of mercury. Organic mercury compounds are commonly used for seed dressing. Various mercury preparations are now favoured by some people for controlling such diseases as Apple Scab, which is caused by the fungus *Venturia inæqualis*. In particular 2½ per cent phenyl mercury acetate is considered to be very promising for this purpose, and this is applied as a spray containing about 0·003 per cent of mercury. This mercury is not just a preventive; it has a definite curative effect, as have copper oxychloride and some carbonates. It gives a measure of control at least equal to that of lime sulphur. Its one drawback is the fact that it is washed off by rain and dew, so it does not afford such lasting protection as copper oxychloride.

The antibiotics are being tested on a grand scale against fungus diseases. Those that have been tried include gliotoxin, penicillin, streptomycin, viridin, antimysin, actidione, musarin, alternatic acid subtilin, endomycin, helixin, fungocin, toximycin, Antibiotic XG and griseofulvin.

One report by Anderson and Gottlieb of the University of Illinois says that none of these antibiotics shows promise for general use as a fungicide, though each of them might find limited and specialised application. Streptomycin and penicillin have been used successfully against a few plant diseases, including certain bacterial diseases; for example, crown gall and the necrosis of giant cacti; these two antibiotics might be useful for seed treatment to prevent certain pathogenic fungi from growing.

Gliotoxin is supposed to play a part in determining the balance of the micro-flora in soils; this compound has not yet been isolated from any soil sample though the fungus which produces it (*Gliocladium fimbriatum*) commonly occurs in the soil. Gliotoxin is effective when applied as a seed dressing, though it is inferior all round to organic mercury compounds for this purpose. Antimycin is effective against Apple Scab and Apple Blight. Actidione seems to be promising against some specific diseases, but its toxicity to some crop plants militates against its general use. This compound could be marketed quite cheaply, being obtained as a by-product of streptomycin fermentation.

There has recently been a good deal of talk about systemic fungicides which can act against fungi in the same kind of way as systemic insecticides work against insects. Here work has concentrated on certain chlorinated b-naphthols and naphthoxy-aliphatic carboxylic acids. The results look encouraging; for example, 3:4-dichlorona-

path-oxyacetic acid thoroughly upsets the growth of certain fungi at a concentration of 6 parts per million. (Curiously this type of compound is more effective as a systemic fungicide than are some other chemicals which proved more potent than this acid in a series of *in vitro* tests.)

The last fifteen years has brought widespread recognition of the great potentialities of industrial mycology. As a result mycologists in general are beginning to be properly appreciated, and it is to be hoped that this will lead to a new burst of research activity in the agricultural mycology field comparable to that which took place in the 19th century. This time the research effort should be not mainly a botanical effort, but a combined operation in which genticists and biochemists should be deployed alongside the mycologists. A research project of that type should yield results of fundamental importance, results that could inspire plant breeders to tackle from new angles the question of breeding for disease resistance, while the biochemists could unravel some of the threads involved in the complex pattern of host/parasite relationships and figure out some rational basis for fungicide research and the chemotherapy proper to plant diseases.

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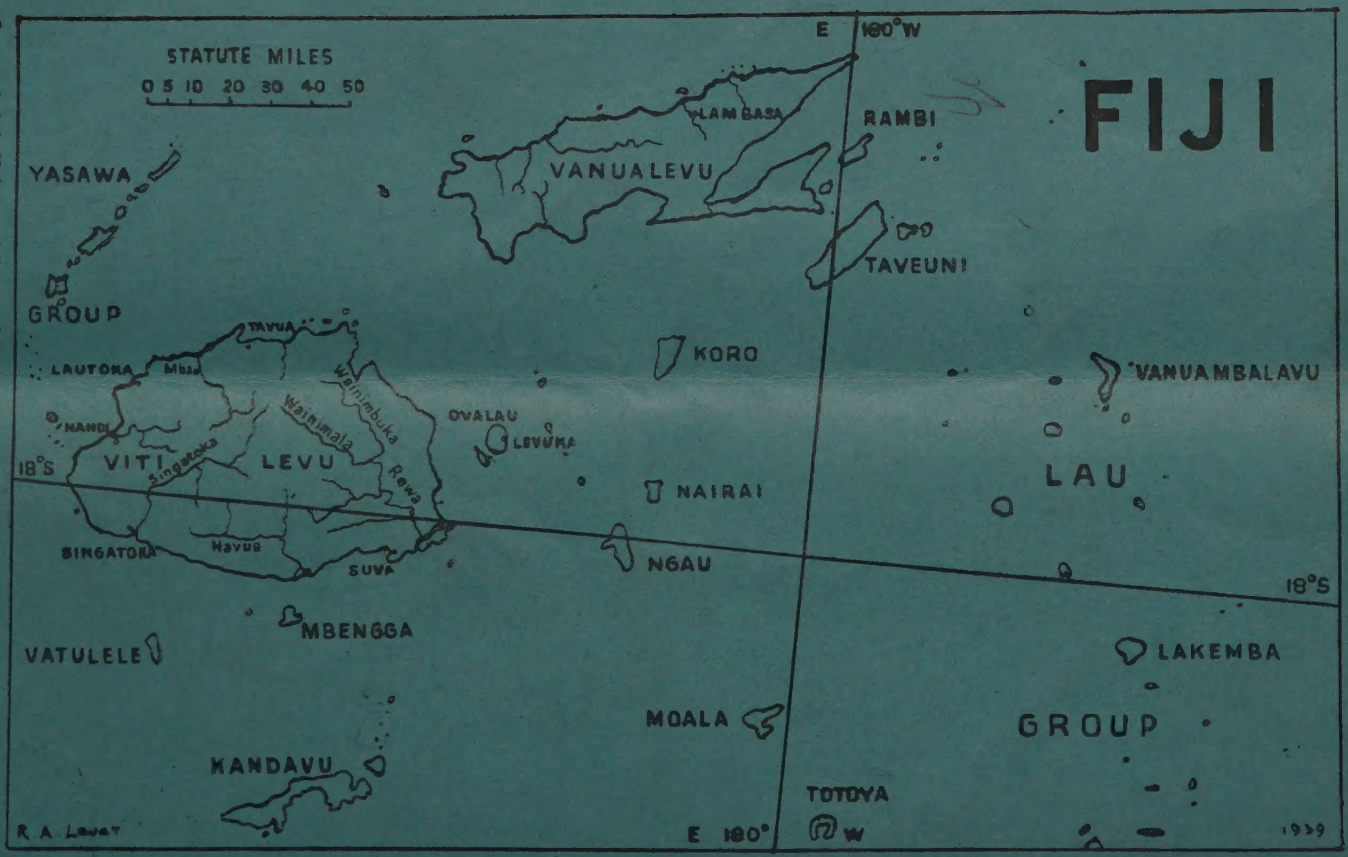

So as to include Kadavu and Totoya within the framework available the map has been rotated some 6° to the east.